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Ground-water Division
555 Federal Building, Honolulu, T. H.

January 18, 1948

Mr. C. E. Meinger
Geologist in Charge
Division of Ground Water
U. S. Geological Survey
Washington, D. C.

Dear Mr. Meinger:

Enclosed is a print of my log of the Red Hill water development tunnel to be attached to my report dated April 12, 1941, in your files.

You will note that the report called for the development of 30 million gallons per day but that we succeeded in developing 29 million gallons per day.

Yours truly,

H. T. Stearns (jb)
Senior Geologist

HTS/jb

enclosure

A Maui-type well for the U. S. Navy at Red Hill, Oahu

By Harold T. Stearns
Senior Geologist, U. S. Geological Survey

April 12, 1941

Synopsis

Methods for developing 80 million gallons a day adjacent to the pipe-line tunnel at Red Hill, Oahu, by a Maui-type well^{1/} are described. It is

✓ Stearns, H. T., Supplement to the geology and ground-water resources of the island of Oahu, Hawaii: Bureau of Hydrography, Bull. 8, p. 9, 1940.

not built It is proposed that the bottom of the well shaft be riddled with 4-inch holes below water level, using the air-drill equipment at the site, and that the well be equipped with deep-well turbines set at the collar of the shaft. The water will stand about 26 feet above sea level and the salt content probably will not exceed 6 grains per gallon when encountered. If sufficient water cannot be developed by the borings, or if the salt content rises too high for domestic use after pumping, a horizontal tunnel from the bottom of the shaft will remedy either condition.

Introduction

On April 9, 1941, at the request of Lt.-Comdr. Ben P. Bush, the Red Hill underground fuel-storage project was examined to determine a site and method for developing 20 million gallons of water a day. Mr. B. A. Peters, in charge of construction, and Lt.-Comdr. Bush accompanied the writer and gave valuable suggestions.

Hydrologic conditions

The basal water supplying artesian area 4 moves outward through the Ko'olau basalt in Red Hill.^{1/} The water table stands at an altitude between 24 and 26 feet, depending upon the season. The salt content of

^{1/} For details of hydrologic conditions in area 4 and principles governing the occurrence of ground water on Oahu, see Stearns, H. T., and Yakovik, K. N., Geology and ground-water resources of the island of Oahu, Hawaii: Hawaii Div. of Hydrography, Bull. 1, 1936; and Stearns, H. T., Supplement to the geology and ground-water resources of the island of Oahu, Hawaii: Hawaii Div. of Hydrography, Bull. 6, 1940.

the water is probably not more than 6 grains per gallon. The proposed Maui-type well must encounter water in Ko'olau basalt to be successful. The well shaft is to be driven alongside the pipe-line tunnel now being extended to Pearl Harbor from its intersection with the lower access tunnel, ~~shoulder-tunnel~~. According to Mr. Peters, the tunnel is being driven on a down grade of 1 foot in 100 feet. The tunnel will leave basalt and enter caprock in the vicinity of Aliamanu Crater, which is about a mile seaward of the intersection. Potable water can be developed at any point along this mile.

Site for well

The site for the well shaft was selected alongside the cut-off pipe-line tunnel at the intersection of the pipe-line tunnel and lower access tunnel 100 feet above sea level, where the depth of the shaft will be about 75 feet, for the following reasons:

The depth to water diminishes^{as} the pipe-line tunnel approaches Aliamanu Crater at the rate of 1 foot per 100 feet due to the down grade of the tunnel in that direction. Therefore, should a site be chosen closer to Aliamanu Crater than the intersection site, a saving of 1,000 feet of pipe and 10 feet of shaft would be effected for every 1,000 feet the site is moved seaward. If excavated

6,000 feet seaward of the intersection, the shaft will be only 35 feet deep, and the pipe line will be 8,000 feet shorter. At the present time the ground-water draft in this ridge is small, but heavy pumping in the future by the Board of Water Supply of Honolulu or by other water users in this general area may cause the water table to decline and the salt to increase. If such hydrologic changes occur, it would be advantageous to locate the well at the intersection rather than farther seaward; hence the cost of the additional excavation may be considered an insurance investment. Also, if the pressure storage tank now in use at Pearl Harbor is moved to a similar elevation underground in Red Hill, no final saving in pipe line will result, as the only feasible site for such a tank is inland from the intersection.

Mr. Peters stated that the heavy underground traffic during the current construction of oil tanks at Red Hill makes the cut-off pipe-line tunnel the most feasible place to excavate a well. He stated also that although pump machinery can be moved through the tunnel to a site nearer Aliamanu Crater, the completed pipe-line tunnel will be too small to allow transportation of transformers.

These are engineering problems, but the fact that water can be developed at a shallower depth farther seaward in the tunnel may be worthy of consideration.

Methods for developing the water

Experience at the new well shaft (U.S.G.S. no. 8) at Red Plantation has shown the great advantage of sinking a vertical shaft, if danger of destruction from bombs is not a determining factor as was the case at the U.S. Navy Alice shaft (U.S.G.S. no. 6). The rock cover above the Red Hill pipe-line tunnel is ample along its entire length; hence it is suggested that a vertical rather than an inclined shaft be sunk. The chief advantage of a vertical shaft is that it can be equipped with vertical centrifugal pumps or with deep-well turbines, allowing the whole pumping station to be built at the top of the shaft. This eliminates lining the shaft, stairs and truck or elevator, and a pump chamber at the bottom of the shaft, etc. It will be worth while probably to gunite the walls of the shaft while the equipment is on the ground, but experience with this rock indicates that there is little danger of the walls caving after all loose rocks have been removed. The pumps should be set close to one wall in order to allow access for developing additional water in the future.

The large compressors and drills on the job make it possible to develop most and perhaps all the water in a slightly different manner than is customary. After the shaft is sunk as deeply below the water as possible to make a sump for the pumps, the bottom should be riddled with 4-inch holes. Mr. Peters states that the equipment on hand will drill such holes about 60 feet below the water. This method parallels the one used to develop the water in the Schofield shaft (U.S.G.S. no. 4), except that 10-inch holes were bored with a well-drilling machine.

Another advantage of a vertical shaft is that permanent pumps can be installed and used for testing as soon as the borings are completed. If excavation is continued after the pumps are installed, tiny sharp fragments of lava carried along in the water may cause wear on the impellers, but they can be replaced when worn out.

Whether the borings will develop 20 million gallons a day depends upon the permeability of the rock encountered. Several large caverns in the lava have been encountered in the oil-tank excavations. If a similar cavern were struck, ample water would be developed.

If sufficient water is not developed by the borings, it will be necessary to tunnel horizontally in the most permeable layer at or about sea level. If a draft of 80 million gallons a day causes the salt content to rise too high for domestic use, it will be possible to tunnel horizontally and thereby reduce the salt content by distributing the draft over a larger area.

Quality

The quality of the water may be appreciably better at Red Hill than in the Aies shaft, due to lack of irrigation on adjacent lands. In this case it will be preferable to use the Red Hill well for the regular supply of Pearl Harbor Navy Yard, keeping the Aies shaft as a standby plant.

U.S. NAVY RED HILL WATER-DEVELOPMENT TUNNEL

LOG BY HAROLD T. STEARNS, U. S. GEOLOGICAL SURVEY, HONOLULU, T. H.



{Upper lift started
July 21, 1942
Lower lift started
Sept. 1, 1942

Shaft

Bottom - 10 feet, yield about $1\frac{1}{2}$ m.g.d.
salt content 12 grains per gallon
Completed July 14, 1942

PLAN

Upper lift was
dry to this point →
3½ min. d. Oct. 9, 1942

5 m.g.d.
Nov. 6/842

S 46° 21' E

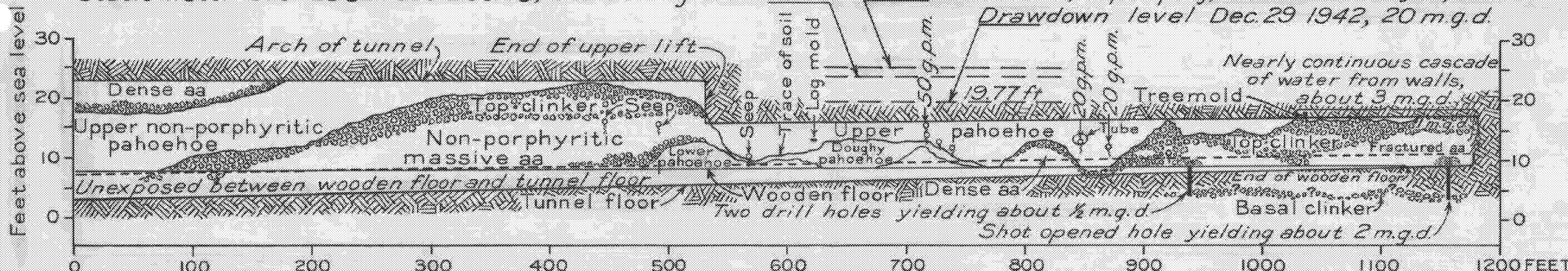
Nov 24, 1942
12 m.g.d.

29 m.g.d.
Dec. 31, 1942
SS/t content 8% gr.p.g.

LOG

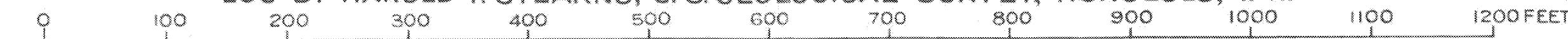
Static water level 2382 feet Dec. 28, 1942 during shut down

Static water level, no pumping, 25.8 feet on July 16, 1942
Drawdown level Dec. 29 1942, 20 m.g.d.

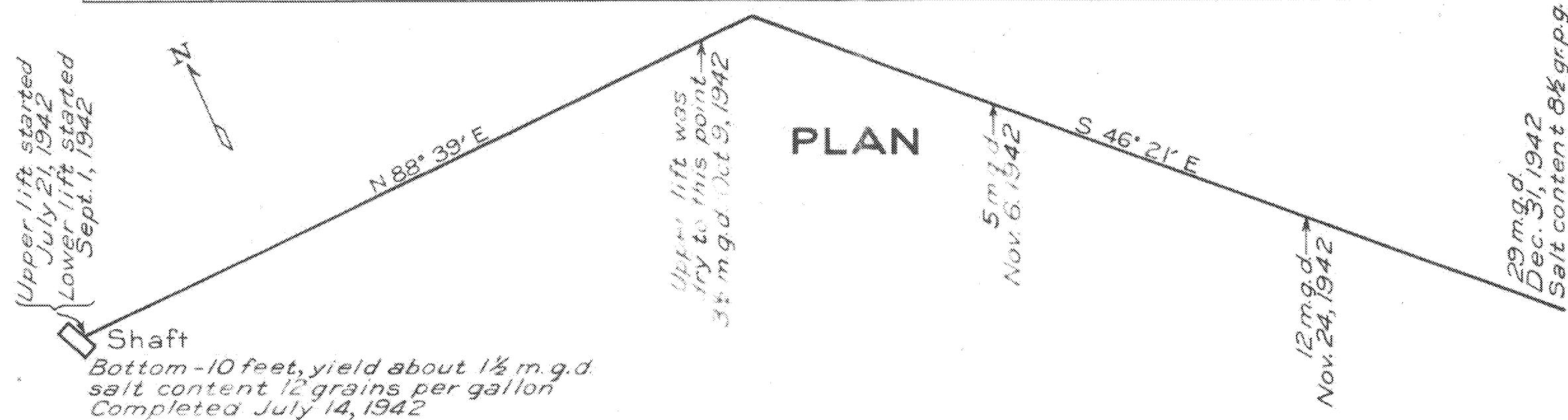


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PLAN



LOG

